

CLAIMS

(1) A carbon nanotube device, characterized in that a carbon nanotube structure layer having a network structure in which plural carbon nanotubes mutually cross-link, is formed in an arbitrary pattern on a surface of a base body.

(2) A carbon nanotube device according to claim 1, characterized in that the carbon nanotube structure layer is obtained by: curing a solution containing carbon nanotubes having functional groups and a cross-linking agent which prompts a cross-linking reaction with the functional groups; and subjecting the functional groups of the carbon nanotubes and the cross-linking agent to a cross-linking reaction to form a cross-linked site.

(3) A carbon nanotube device according to claim 2, characterized in that the cross-linking agent comprises a not-self-polymerizable cross-linking agent.

(4) A carbon nanotube device according to claim 2, characterized in that the cross-linked site comprises a cross-linking structure in which residues of the functional groups remaining after the cross-linking reaction are connected together with a connecting group employing a hydrocarbon as its skeleton.

(5) A carbon nanotube device according to claim 4, characterized in that the connecting group employs a hydrocarbon having 2 to 10 carbon atoms as its skeleton.

(6) A carbon nanotube device according to claim 2, characterized in that:

the functional groups comprise at least one functional group selected from the group consisting of -OH, -COOH, -COOR (where R represents a substituted or unsubstituted hydrocarbon group), -COX (where X represents a halogen atom), -NH₂, and -NCO; and

the cross-linking agent comprises a cross-linking agent capable of prompting a cross-linking reaction with the selected functional groups.

(7) A carbon nanotube device according to claim 2, characterized in that:

the cross-linking agent comprises at least one cross-linking agent selected from the group consisting of a polyol, a polyamine, a polycarboxylic acid, a polycarboxylate, a polycarboxylic acid halide, a polycarbodiimide, and a polyisocyanate; and

the functional groups comprise functional groups capable of prompting a cross-linking reaction with the selected cross-linking agent.

(8) A carbon nanotube device according to claim 2, characterized in that:

the functional groups comprise at least one functional group selected from the group consisting of -OH, -COOH, -COOR (where R represents a substituted or unsubstituted hydrocarbon group), -COX (where X represents a halogen atom), -NH₂, and -NCO;

the cross-linking agent comprises at least one cross-linking agent selected from the group consisting of a polyol, a polyamine, a polycarboxylic acid, a polycarboxylate, a polycarboxylic acid halide, a polycarbodiimide, and a polyisocyanate; and

the functional groups and the cross-linking agent are respectively selected for a combination capable of prompting a mutual cross-linking reaction.

(9) A carbon nanotube device according to claim 2, characterized in that the functional groups comprise -COOR (where R represents a substituted or unsubstituted hydrocarbon group).

(10) A carbon nanotube device according to claim 9, characterized in that the cross-linking agent comprises a polyol.

(11) A carbon nanotube device according to claim 9, characterized in that the cross-linking agent comprises glycerin and/or ethylene glycol.

(12) A carbon nanotube device according to claim 1, characterized in that the cross-linked site where plural carbon nanotubes mutually cross-link has a chemical structure selected from the group consisting of $-\text{COO}(\text{CH}_2)_2\text{OCO}-$, $-\text{COOCH}_2\text{CHOHCH}_2\text{OCO}-$, $-\text{COOCH}_2\text{CH}(\text{OCO}-)\text{CH}_2\text{OH}$, and $-\text{COOCH}_2\text{CH}(\text{OCO}-)\text{CH}_2\text{OCO}-$.

(13) A carbon nanotube device according to claim 1, characterized in that at least part of the arbitrary pattern comprises a pattern constituting an electrical component.

(14) A carbon nanotube device according to claim 1, characterized in that at least part of the arbitrary pattern comprises a pattern constituting an electrical wiring.

(15) A carbon nanotube device according to claim 14, characterized in that the plural carbon nanotubes comprise multi-wall carbon nanotubes.

(16) A carbon nanotube device according to claim 14, characterized by further comprising another electrical component connected to the carbon nanotube structure layer formed in the pattern constituting an electrical wiring.

(17) A carbon nanotube device according to claim 1, characterized in that the base body has plasticity or flexibility.

(18) A method of manufacturing a carbon nanotube device, characterized by comprising:

an applying step of applying to a surface of a base body a solution containing plural carbon nanotubes having functional groups and a cross-linking agent which prompts a cross-linking reaction with the functional groups;

a cross-linking step of mutually cross-linking the plural carbon nanotubes to construct a network structure through curing of the solution after the application to thereby form a carbon nanotube structure layer having the network structure; and

a patterning step of patterning the carbon nanotube structure layer into a pattern corresponding to a desired device.

(19) A method of manufacturing a carbon nanotube device according to claim 18, characterized in that the cross-linking agent comprises a not-self-polymerizable cross-linking agent.

(20) A method of manufacturing a carbon nanotube device according to claim 18, characterized in that the patterning step comprises a step in which the carbon nanotube structure layer in a region on the surface of the base body other than a pattern

corresponding to the desired device is subjected to dry etching to remove the carbon nanotube structure layer in the region, whereby the carbon nanotube structure layer is patterned into a pattern corresponding to the desired device.

(21) A method of manufacturing a carbon nanotube device according to claim 18, characterized in that the patterning step includes:

a resist layer forming step of forming a resist layer above the carbon nanotube structure layer in a region on the surface of the base body having the pattern corresponding to the desired device; and

a removing step of removing the carbon nanotube structure layer exposed in a region other than the region by subjecting a surface of the base body on which the carbon nanotube structure layer and the resist layer are laminated to dry etching.

(22) A method of manufacturing a carbon nanotube device according to claim 21, characterized in that, in the removing step, the surface of the base body on which the carbon nanotube structure layer and the resist layer are laminated is irradiated with an oxygen molecule radical.

(23) A method of manufacturing a carbon nanotube device

according to claim 21, characterized in that oxygen molecules are irradiated with ultraviolet rays to generate an oxygen molecule radical, which is used as a radical with which the surface of the base body on which the carbon nanotube structure layer and the resist layer are laminated is irradiated.

(24) A method of manufacturing a carbon nanotube device according to claim 21, characterized in that the patterning step further includes a resist layer peeling-off step of peeling off the resist layer formed in the resist layer forming step subsequent to the removing step.

(25) A method of manufacturing a carbon nanotube device according to claim 21, characterized in that the resist layer comprises a resin layer.

(26) A method of manufacturing a carbon nanotube device according to claim 18, characterized in that the patterning step comprises a step of patterning the carbon nanotube structure layer into the pattern corresponding to the desired device by selectively irradiating the carbon nanotube structure layer in a region of the surface of the base body other than the region having the pattern corresponding to the desired device with an ion beam of a gas molecule to remove the carbon nanotube structure layer in the region.

(27) A method of manufacturing a carbon nanotube device according to claim 18, characterized in that the patterning step includes:

a resist layer forming step of forming a resist layer above the carbon nanotube structure layer in a region on the surface of the base body having the pattern corresponding to the desired device; and

a removing step of removing the carbon nanotube structure layer exposed in a region other than the region by bringing a surface of the base body on which the carbon nanotube structure layer and the resist layer are laminated into contact with an etchant.

(28) A method of manufacturing a carbon nanotube device according to claim 18, characterized in that:

the functional groups comprise at least one functional group selected from the group consisting of -OH, -COOH, -COOR (where R represents a substituted or unsubstituted hydrocarbon group), -COX (where X represents a halogen atom), -NH₂, and -NCO; and

the cross-linking agent comprises a cross-linking agent capable of prompting a cross-linking reaction with the selected functional groups.

(29) A method of manufacturing a carbon nanotube device

according to claim 18, characterized in that:

the cross-linking agent comprises at least one cross-linking agent selected from the group consisting of a polyol, a polyamine, a polycarboxylic acid, a polycarboxylate, a polycarboxylic acid halide, a polycarbodiimide, and a polyisocyanate; and

the functional groups comprise functional groups capable of prompting a cross-linking reaction with the selected cross-linking agent.

(30) A method of manufacturing a carbon nanotube device according to claim 18, characterized in that:

the functional groups comprise at least one functional group selected from the group consisting of -OH, -COOH, -COOR (where R represents a substituted or unsubstituted hydrocarbon group), -COX (where X represents a halogen atom), -NH₂, and -NCO;

the cross-linking agent comprises at least one cross-linking agent selected from the group consisting of a polyol, a polyamine, a polycarboxylic acid, a polycarboxylate, a polycarboxylic acid halide, a polycarbodiimide, and a polyisocyanate; and

the functional groups and the cross-linking agent are respectively selected for a combination capable of prompting a mutual cross-linking reaction.

(31) A method of manufacturing a carbon nanotube device

according to claim 18, characterized in that the functional groups comprise -COOR (where R represents a substituted or unsubstituted hydrocarbon group).

(32) A method of manufacturing a carbon nanotube device according to claim 31, characterized in that the cross-linking agent comprises a polyol.

(33) A method of manufacturing a carbon nanotube device according to claim 31, characterized in that the cross-linking agent comprises glycerin and/or ethylene glycol.

(34) A method of manufacturing a carbon nanotube device according to claim 18, characterized in that the solution further contains a solvent.

(35) A method of manufacturing a carbon nanotube device according to claim 34, characterized in that the cross-linking agent also functions as a solvent.

(36) A method of manufacturing a carbon nanotube device according to claim 18, characterized in that a base body having plasticity or flexibility is used as the base body.

(37) A method of manufacturing a carbon nanotube device, characterized by comprising:

an applying step of applying to a surface of a temporary substrate a solution containing plural carbon nanotubes having functional groups and a cross-linking agent which prompts a cross-linking reaction with the functional groups;

a cross-linking step of mutually cross-linking the plural carbon nanotubes to construct a network structure through curing of the solution after the application to thereby form a carbon nanotube structure layer having the network structure;

a patterning step of patterning the carbon nanotube structure layer into a pattern corresponding to a desired device; and

a transferring step of transferring the patterned carbon nanotube structure layer onto a base body.

(38) A method of manufacturing a carbon nanotube device according to claim 37, characterized in that a substrate having plasticity or flexibility is used as the base body.

(39) A method of manufacturing a carbon nanotube device according to claim 37, characterized by further comprising, after the transferring step, a pattern fixing step of fixing the patterned carbon nanotube structure layer transferred onto the surface of the base body to a second base body together with the base body.

(40) A method of manufacturing a carbon nanotube device according to claim 37, characterized in that the transferring step comprises a step in which the patterned carbon nanotube structure layer on the surface of the temporary substrate is once transferred onto a surface of an intermediate transfer body, and the carbon nanotube structure layer transferred onto the surface of the intermediate transfer body is transferred onto the base body.

(41) A method of manufacturing a carbon nanotube device according to claim 37, characterized in that the cross-linking step includes a step of heating the carbon nanotube structure layer formed on the surface of the temporary substrate at a temperature which is lower than a melting point of the temporary substrate and is equal to or higher than a melting point or a glass transition point of the base body to cure the solution after the application.

(42) A method of manufacturing a carbon nanotube device according to claim 40, characterized in that the cross-linking step includes a step of heating the carbon nanotube structure layer formed on the surface of the temporary substrate at a temperature which is lower than the melting point of the temporary substrate and is equal to or higher than a melting point or a glass transition point of the intermediate transfer body to cure the solution after the

application.

(43) A method of manufacturing a carbon nanotube device according to claim 37, characterized in that the patterning step comprises a step in which the carbon nanotube structure layer in a region on the surface of the temporary substrate other than a region having the pattern corresponding to the desired device is subjected to dry etching to remove the carbon nanotube structure layer in the region, whereby the carbon nanotube structure layer is patterned into a pattern corresponding to the desired device.

(44) A method of manufacturing a carbon nanotube device according to claim 43, characterized in that the base body has no resistance to the dry etching performed in the patterning step, but the temporary substrate has resistance to the dry etching.

(45) A method of manufacturing a carbon nanotube device according to claim 40, characterized in that:

the patterning step comprises a step in which the carbon nanotube structure layer in a region on the surface of the temporary substrate other than a region having the pattern corresponding to the desired device is subjected to dry etching to remove the carbon nanotube structure layer in the region, whereby the carbon nanotube structure layer is patterned into a pattern corresponding to the

desired device; and

the intermediate transfer body has no resistance to the dry etching performed in the patterning step, but the temporary substrate has resistance to the dry etching.

(46) A method of manufacturing a carbon nanotube device according to claim 37, characterized in that the patterning step includes:

a resist layer forming step of forming a resist layer above the carbon nanotube structure layer in a region on the surface of the temporary substrate having the pattern corresponding to the desired device; and

a removing step of removing the carbon nanotube structure layer exposed in a region other than the region by bringing a surface of the temporary substrate on which the carbon nanotube structure layer and the resist layer are laminated into contact with an etchant.

(47) A method of manufacturing a carbon nanotube device according to claim 46, characterized in that the base body has no resistance to the etchant used in the patterning step, but the temporary substrate has resistance to the etchant.

(48) A method of manufacturing a carbon nanotube device according to claim 37, characterized in that:

the patterning step includes:

a resist layer forming step of forming a resist layer above the carbon nanotube structure layer in a region on the surface of the temporary substrate having the pattern corresponding to the desired device; and

a removing step of removing the carbon nanotube structure layer exposed in a region other than the region by bringing a surface of the temporary substrate on which the carbon nanotube structure layer and the resist layer are laminated into contact with an etchant; and

the intermediate transfer body has no resistance to the etchant used in the patterning step, but the temporary substrate has resistance to the etchant.

(49) A carbon nanotube transfer body, characterized in that:

a carbon nanotube structure layer having a network structure in which plural carbon nanotubes mutually cross-link, is carried on a surface of a temporary substrate;

the carbon nanotube transfer body is used for transferring the carbon nanotube structure layer having a pattern corresponding to a desired device onto a base body; and

the temporary substrate is removed from the base body when the carbon nanotube structure layer is transferred onto the base body.

(50) A carbon nanotube transfer body according to claim 49, characterized in that:

the carbon nanotube structure layer is obtained by: curing a solution containing carbon nanotubes having functional groups and a cross-linking agent which prompts a cross-linking reaction with the functional groups; and subjecting the functional groups of the carbon nanotubes and the cross-linking agent to a cross-linking reaction to form a cross-linked site; and

the cross-linking agent comprises a not-self-polymerizable cross-linking agent.

(51) A carbon nanotube transfer body according to claim 49, characterized in that the temporary substrate comprises a substrate having plasticity or flexibility.